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OFFICE OF
PREVENTION, PESTICIDES
AND
TOXIC SUBSTANCES

Memorandum

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SUBJECT: Initial Biological and Economic Benefits Assessment for Azinphos-methyl on Cabbage

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SUMMARY

Based on available published information and personal communications with crop experts, BEAD believes that there will be little impact resulting from extending the restricted entry intervals for azinphos-methyl on cabbage. Few growers are using azinphos-methyl on cabbage and there are effective alternatives available. BEAD believes that growers currently using azinphos-methyl will switch to the alternative compounds.

BACKGROUND

Cabbage, *Brassica oleracea*, is a cool-season biennial that is grown as an annual vegetable. Cole crops tend to be high risk vegetable crops. They are attacked by a variety of pests and consequently pest management tends to be quite complex.

Production Practices

Most cabbage in New York is transplanted either as bare-root seedlings or as plug transplants, but a considerable portion of the crop grown for late summer or fall harvest is direct-seeded. Planting of fresh market cabbage usually begins in late April or early May in upstate New York and one to two weeks earlier on Long Island. Storage cabbage is usually transplanted in June or early July for mid- to late-fall harvest. Some growers direct-seed their crops relatively early in the spring.

Cabbage has shallow root systems and therefore water management is very critical. In dry seasons, fresh market cabbage, and less frequently storage and processing cabbage, are usually irrigated. Cultivation is absolutely necessary for weed control and to aerate the soil.

Processing cabbage is harvested almost entirely by machine (about 20% of New York acreage), but fresh-market and storage cabbage are hand-harvested. Harvest may begin as early as the first week of July, continuing through the fall. Storage and processing harvests run from mid-October through November.

Michigan production practices differ from those in New York in that Michigan cabbage seeds are sown in early April and periodically thereafter to allow for a constant supply of cabbage. After planting, the soil is drenched with an insecticide to avoid cutworm and maggot damage. The transplanting of seedlings begins in May and continues through mid-July. Harvesting begins in early July and continues into the fall.

Production Data for Cabbage:

U.S. Cabbage Production

Total U.S. fresh market cabbage production was 2.2 billion pounds in 1999, and was valued at $231.7 million. The top six production States (in terms of pounds of production), which account for 80% of total U.S. production, are New York (496 million pounds), California (413 million pounds), Texas (313 million pounds), Georgia (227 million pounds), Florida (208 million pounds) and North Carolina (129 million pounds) (Table 1).

Table 1. Cabbage for Fresh Market: 1999 Area, Production, and Value of Production in the U.S. by State.

U.S./State	Harvested Acreage (Acres)	Production (million pounds)	Percent of U.S. Production	Value of Production ($1000)
United States	74,850	2,207	100%	$231,735
California	12,500	413	19%	$55,755
Colorado	2,300	83	4%	$6,972
Florida	8,500	208	9%	$20,800
Georgia	8,100	227	10%	$19,976
Illinois	1,000	13	1%	$1,161
Missouri	600	9	0%	$1,620
Michigan	1,800	50	2%	$4,300
New Jersey	1,600	40	2%	$5,200
New York	12,100	496	22%	$45,632

U.S./State	Harvested Acreage (Acres)	Production (million pounds)	Percent of U.S. Production	Value of Production ($1000)
North Carolina	7,600	129	6%	$10,965
Ohio	1,300	25	1%	$2,825
Pennsylvania	1,700	28	1%	$3,724
Texas	9,200	313	14%	$41,316
Virginia	1,300	48	2%	$2,400
Wisconsin	4,700	111	5%	$8,214
Hawaii	550	14	1%	$3,220

Source: USDA/NASS Agricultural Statistics 2000.

Total U.S. production of cabbage for the kraut market was 178 million pounds in 1999, and was valued at $4.3 million. The top two production States (in terms of pounds of production), which account for 93% of total U.S. production, are Wisconsin (81 million pounds) and New York (68 million pounds) (Table 2).

Table 2. Cabbage for Kraut: 1999 Area, Production and Value of Production in the U.S.

U.S./State	Harvested Acreage (Acres)	Production (million pounds)	Percent of U.S. Production	Value of Production ($1000)
United States	6,180	178	100%	$4,318
New York	2,400	68	38%	$1,670
Wisconsin	2,700	81	45%	$1,573
Other States/1	1,080	29	16%	$1,081

Source: USDA/NASS Agricultural Statistics 2000.
/1 Other states include Michigan, Ohio, Oregon, and Washington.

USE OF AZINPHOS-METHYL ON CABBAGE

Azinphos-methyl Usage by State

Tables 3 and 4 list the usage of azinphos-methyl on cabbage in the fresh and kraut markets by state. The tables provide data on percent of crop treated, base acres treated, total pounds of active ingredient applied, average number of applications per year, and average application rates per acre. Most of the data is from the National Agricultural Statistics Service's Agricultural Chemical Usage, Vegetable Summary covering crop year 1998. California usage data, however, is from the California Department of Pesticide Regulation's pesticide use reporting system and azinphos-methyl usage data for fresh market cabbage grown in Ohio and Wisconsin is from the National Center for Food and Agricultural Policy.

Approximately 6% of the U.S. cabbage acreage is treated with azinphos-methyl per year, and 3,000 pounds of azinphos-methyl are applied. In terms of pounds of active ingredient applied and acres treated, New York is the leading state using an estimated 1,700 pounds on 2,073 acres, which is 16% of the State's total fresh market cabbage acreage (Table 3).

Table 3. Usage of Azinphos-methyl on Fresh Market Cabbage by Major State [1]

U.S./State	Percent of Crop Treated	Base Acres Treated [1] (acres)	Total Pounds Applied (lbs)	Average Number of Applications (#/year)	Average Application Rate (lbs/acre) [3]
United States [2]	6%	5,000	3,000	1.0	0.5
California [3]	<0.5%	25	16	1.0	0.5
Colorado	0	0	0	-	-
Florida	0	0	0	-	-
Georgia	NP	NP	NP	NP	NP
Illinois	0	0	0	-	-
Missouri	0	0	0	-	-
Michigan	17%	385	100	10	0.26
New Jersey	NP	NP	NP	NP	NP
New York	16%	2,073	1,700	1.4	0.57
North Carolina	NP	NP	NP	NP	NP
Ohio [4]	17%	221	77	1.0	0.26
Pennsylvania	0	0	0	-	-
Texas	0	0	0	-	-
Virginia	0	0	0	-	-
Wisconsin [4]	2%	94	71	1.0	0.5
Hawaii	0	0	0	-	-

Source: USDA/NASS Vegetable Chemical Use, 2000 unless otherwise indicated.
'NP' indicates that usage was observed and that data were collected by NASS but were not published.
A dash (-) indicates that data were either not available or not applicable.
1. Base acres treated calculated using percent of crop treated estimates and bearing acreage from Table 1.
2. US EPA Quantitative Usage Analysis (QUA), 4/99, estimates an average of 6% of the total cabbage crop treated and 3,000 pounds applied in the U.S. Based on ten years of data and multiple data sources.
3. Source: California Department of Pesticide Regulation, average of 1998 and 1999 census data.
4. Source: National Center for Food and Agricultural Policy, 1997 estimates.

Specific data on azinphos-methyl usage on cabbage for kraut are not published. However, usage at the national level and state level for New York was observed by the NASS. This indicates that some level of usage took place. NASS surveyed Wisconsin cabbage for kraut, but did not report usage, thus azinphos-methyl usage in Wisconsin equals zero (Table 4).

Table 4. Usage of Azinphos-methyl on Cabbage for Kraut by Major State

U.S./State	Percent of Crop Treated	Base Acres Treated (acres)	Total Pounds Applied (lbs)	Average Number of Applications (#/year)	Average Application Rate (lbs/acre)
United States	NP	NP	NP	NP	NP
New York	NP	NP	NP	NP	NP
Wisconsin	0	0	0	-	-
Other States	-	-	-	-	-

Source: USDA/NASS Vegetable Chemical Use, 2000.
'NP' indicates that usage was observed and that data were collected by NASS but were not published.
A dash (-) indicates that data were either not available or not applicable.

Target Pests

Azinphos-methyl is recommended for cabbage root maggot *(Delia brassicae*), and imported cabbageworm *(Pieris rapae*), diamondback moth *(Plutella maculipennis)*, and cabbage looper *(Trichoplusia ni).* In addition to these insect pests, Michigan growers have pest pressure from flea beetles for which azinphos-methyl is recommended.

The primary pest in New York is the imported cabbageworm, which is a secondary pest in Michigan. The adults, the white butterflies often seen around cruciferous crops, overwinter as pupae and emerge in late April or early May to lay their eggs on the leaves of cole crops and other cruciferous crops and weeds. The larvae eat holes in leaves and leave large amounts of fecal material on the leaves. They migrate from the plant to pupate in the soil. There are commonly 3 generations a year, the adults and larvae may be active until frost.

The primary pest in Michigan is the cabbage root maggot. Flies emerge from the soil in early May. The flies lay eggs near the soil surface or in the soil at the base of cole crops and related weeds. The larvae feed on the roots and lower stems of the cole crops. Young plants usually wilt and die. Mature plants attacked by later generations are weakened and predisposed to fungal diseases. If maggots of later generations burrow into the core of the cabbage, then it is unmarketable. There are usually 3 generations of cabbage root maggots a year in Michigan.

Cabbage looper can be a serious late season pest of cole crops in both New York and Michigan. They cause foliar injury and can be a contaminant at harvest for cole crops; plant damage and product contaminations are similar to that of imported cabbageworm. They do not overwinter in either state, but migrate into the states during July and August. There may be 2 or 3 generations per year depending on weather conditions. As the larvae grow, they become more difficult to control. Cabbage loopers are much more tolerant of insecticides than imported cabbageworms. Proper identification is important, as higher rates or more toxic materials are needed on loopers than on cabbageworms.

In Michigan, diamondback moths (DBM) do not cause major damage, but are often reported. However, in New York, DBM are an annual pest. Adults can migrate from southern states into New York in late April and May, but the majority of the problem appears to be moths which enter the state on southern-grown transplants. While DBM does not overwinter in upstate New York, it does overwinter on Long Island in most years. The larvae eat numerous small holes in the leaves, and sometimes leaves fine webbing in the center of the plant. Foliar injury lowers the quality of the crop, and weakens the plant. The larvae themselves can be a contaminant of the final product. Four to six generations can occur per season. Hot dry conditions favor survival and reproduction, making control difficult. Of the three lepidopteran pests of cabbage, DBM is by far the most difficult to control in New York.

Controls:

Cabbage Root Maggot

There are two chemical controls for the cabbage root maggot. Chlorpyrifos applied as a soil directed spray is the preferred treatment in areas with maggot pressure. Diazinon, incorporated in the soil at plant or as a transplant water treatment, is the second most common practice. Biological control uses a few natural enemies to help regulate the population, but they do not generally maintain the pest levels low enough to avoid economic damage. Cultural controls include crop rotation with plants not of the genus *Brassica*, and *Brassica* weeds must be controlled. There are a few cabbage varieties with resistance to the maggots. Sanitation is important, crop residue should be plowed under immediately after harvesting to reduce the overwintering population of cabbage root maggots.

Lepidoptera Larvae

The following chemicals are used on cabbage to control Lepidoptera larvae. They are listed in order of importance with azinphos-methyl ranking number nine. Order of importance is based on current share of total acres of cabbage treated for control of Lepidoptera larvae. Share of current usage is listed for each active ingredient.

Table 5. Leading Insecticides Used to Control Lepidoptera Larvae in Cabbage.

Insecticide Listed in Order if Importance[1] (Based on Estimated Usage on Lepidoptera Larvae)	Share of Current Usage
Bacillus thuringiensis	30%
Lambda-cyhalothrin	20%
Spinosad	15%
Esfenvalerate	10%
Permethrin	10%
Methomyl	4%
Endosulfan	3%
Dimethoate	1%
Azinphos-methyl	1%
Diazinon	1%
Tebufenozide	1%
Carbaryl	1%
Chlorpyrifos	0%
Fonofos	0%
Methamidophos	0%
Cypermethrin	0%

Sources: EPA proprietary data.

[1] Importance based on the proportion of total insecticide usage (total acre treatments) for the control of Lepidoptera larvae.

Biological controls include several predators and parasitoids that attack the complex of Lepidoptera larvae; however, they often do not keep populations below economic threshold. Cultural control practices include the destruction of crop debris as soon as possible after harvest in minimize spread of Lepidoptera larvae to other plantings.

RESTRICTED ENTRY INTERVALS (REIs)

The current label REIs for azinphos-methyl on *Brassica* is 4 days (5 days in areas with less than 25 inches of rain per year). Please refer to the occupational and residential human health risk assessment on the Agency's website (http://www.epa.gov/pesticides/op) for information concerning the worker risks associated with the restricted entry intervals for this chemical.

IMPACTS RELATED TO OCCUPATIONAL RISK MITIGATION

Maggots are an early season pest when the young cabbage plants are very vulnerable. At this time of the season, there is a need to get into the field weekly for cultivating and hoeing, and possibly to sidedress the plants with fertilizer. The young plants need more care early in the season due to competition with weeds.

When the plants are more established, and when most of the Lepidoptera larvae could occur, there would be little need to get into the field for a couple of weeks after application, except for irrigation and scouting. But hoeing and cultivation could be delayed for a week or two without much economic loss, if late in the season.

Extending the REI for weeding beyond 10 to 14 days would essentially cancel the use of azinphos-methyl on cabbage. However, BEAD believes that the growers currently using azinphos-methyl to control Lepidoptera larvae and cabbage root maggot will switch to other alternatives that are as efficacious and comparable in price. Therefore, BEAD predicts that extended REIs will not impact cabbage production.

References

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